

# Low-Cost Manufacturing Technique for Advanced Regenerative Cooling for In-Space Cryogenic Engines, Phase II

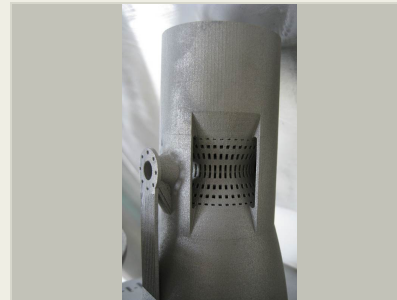
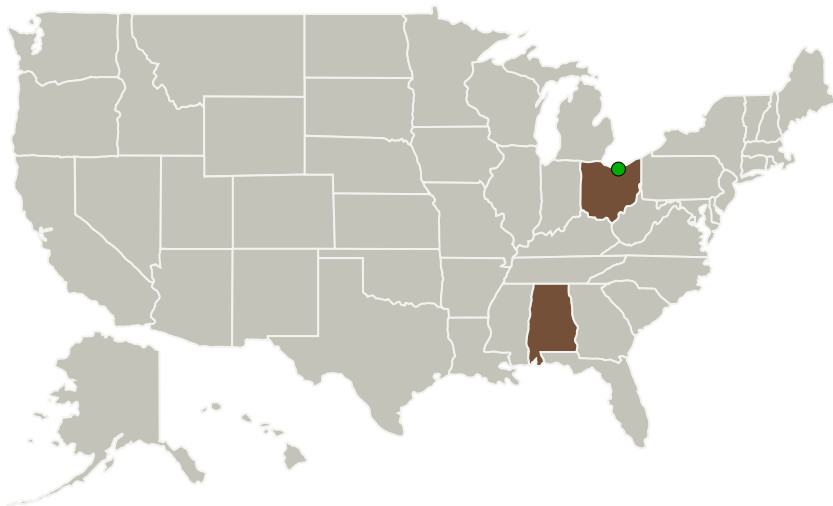
Completed Technology Project (2014 - 2018)



## Project Introduction

The goal of the proposed effort is to use selective laser melting (SLM, an additive manufacturing technique) to manufacture a hot fire-capable, water-cooled spool piece that features an advanced regenerative cooling technique that combines high heat flux performance with low pressure drop. SLM enables us to "print" the spool piece in days, despite the complexity of the regenerative liner's inherent flow passage complexity. This reduction in manufacturing lead time, combined with the fact that SLM manufacturing costs are driven in large part by the amount of raw powder used during fabrication, results in a substantial cost reduction for future regeneratively-cooled rocket engines. Additionally, the proposed advanced regenerative cooling approach features a heat-pickup efficiency that is at least two orders of magnitude higher than traditional milled channel liners and/or brazed tube bundle chambers. As a result of our Phase I activity and confidence in our commercialization path, we will be making a capital investment to stand up an SLM manufacturing capability in house. We plan to augment that investment with an internally-funded trade study that we will use to derive main combustion chamber performance requirements for a future expander cycle engine. Those requirements will feed into Phase II design requirements and, ultimately, to supporting our commercialization opportunity presented by the Affordable Upper Stage Engine Program.

## Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
Analytical Services, Inc. (ASI)	Lead Organization	Industry Small Disadvantaged Business (SDB)	Huntsville, Alabama
● Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

## Primary U.S. Work Locations

Alabama	Ohio
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## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Organization:

Analytical Services, Inc. (ASI)

### Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

### Program Director:

Jason L Kessler

### Program Manager:

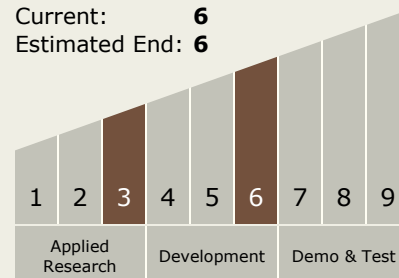
Carlos Torrez

### Principal Investigator:

Joe Sims

## Technology Maturity (TRL)

Start: 3  
Current: 6  
Estimated End: 6

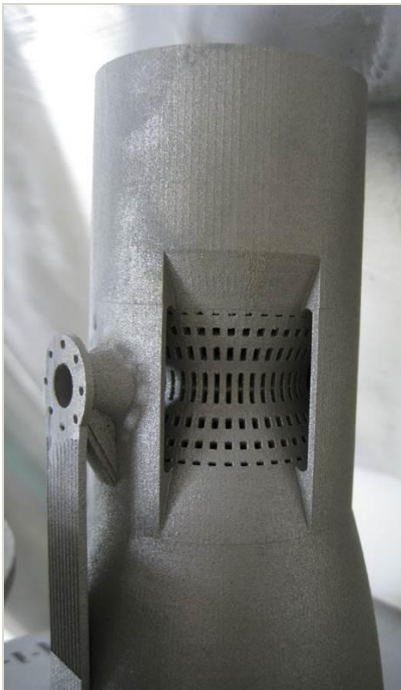


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## Images



### Briefing Chart Image

Low-Cost Manufacturing Technique  
for Advanced Regenerative Cooling  
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(<https://techport.nasa.gov/image/129913>)

## Technology Areas

### Primary:

- TX01 Propulsion Systems
  - └ TX01.2 Electric Space Propulsion
    - └ TX01.2.1 Integrated Systems and Ancillary Technologies

## Target Destinations

The Sun, Earth, The Moon,  
Mars, Others Inside the Solar  
System, Outside the Solar  
System